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A Prospect Theory of Power Transition: Why Power Transition Does Not Imply War?

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Abstract

We present a prospect theory model to explain why power transitions do not necessarily lead to war. We find that three major mechanisms prevent the occurrence of potential power transition wars. First, the dual boiling frog effects occurring in the middle range of capability catching-up rate prevent a dominant state from preempting and a rising state from challenging the other side. Second, divergent expectations for favorable comparative growth advantage motivate both parties to keep the status quo. Third, the concerns of relative advantage deterioration over a third party in the post-war power structure help deter both parties from starting a war.

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1 Introduction

Since Organski (1958) first introduced the power transition theory, it has been believed by many students in international politics that power transitions cause general wars. Intuitively, when a rising state appears to surpass the dominant state in capabilities, the rising state would have incentive to take over the dominant state's leadership while the dominant state would have incentive to preempt the former from doing so. Therefore, war is logically inevitable. However, historically many if not more power transitions did not lead to war (Houweling and Siccama 1988).

Then, why power transitions do not imply war? Kim and Morrow (1992) raise a choice-theoretic model of war decisions during power shifts to explain that the willingness to take risks plays a central role. However, the measurement of risk acceptance of a state is rather difficult and quite possibly inaccurate.

We provide a prospect theory model for a more objective and reliable explanation. We find that three major mechanisms prevent the occurrence of potential power transition wars. First, the dual boiling frog effects occurring in the middle range of capability catching-up rate prevent a dominant state from preempting and a rising state from challenging the other side. Second, divergent expectations for favorable comparative growth advantage motivate both parties to keep the status quo. Third, the concerns of relative advantage deterioration over a third party in the post-war power structure deter even the expected winner from starting a war.

The rest of the paper is organized as follows. Section 2 constructs a dyadic model of power transition war and characterizes the equilibrium of the game. Section 3, Section 4, and Section 5 analyze how the dual boiling frog effects, the effects of expectation divergence, and the concerns of relative advantage deterioration over a third party help to prevent potential power transition wars respectively. Section 6 concludes.

2 The Model

There exist a hegemon (dominant state) and a potential challenger (rising state). The potential challenger appears to be surpassing the hegemon in capabilities. Time is discrete, indexed by t, and the horizon is infinite and common discount factor $\delta \in (0, 1)$. The capabilities of the hegemon is normalized to one. The capabilities of the potential challenger at period t is denoted by y_t, which is growing over time. At each period, the potential challenger must decide whether to challenge the hegemon or to keep the status quo while the hegemon must decide whether to preempt the potential challenger or to keep the status quo. If the potential challenger chooses to challenge, the hegemon must choose to either resist or capitulate. If the hegemon choose to preempt, the potential challenger must choose to either resist or capitulate.

2.1 Stage Game

Consider the stage game in period t, if both the hegemon and potential challenger keep the status quo, the hegemon enjoys the hegemonic bonus, which is normalized to one, while the potential challenger gets the benefit share of the follower, $1/2 > s > 0$.

If the potential hegemon preempts, the potential challenger must decide whether to resist or capitulate. If the potential challenger resists, war begins. The winner will be the single hegemony and enjoy the periodic hegemonic bonus, whereas the loser is out of the game and gets zero thereafter. Instead, if the potential challenger capitulates, the hegemon becomes the single hegemon without war, whereas the potential challenger is out of the game.

If the potential challenger challenges, the hegemon must decide whether to resist or capitulate. If the hegemon resists, war begins. The winner will be the single hegemony and enjoy the periodic hegemonic bonus, whereas the loser is out of the game. If the hegemon capitulates, we have the peaceful power transit, after which the hegemon and the potential challenger exchange their seats. Therefore, the action sets of the potential challenger and the hegemon are $A_1 = \{S(tatus\ quo), C(hallenging), R(esisting), Ca(pitulating)\}$ and $A_2 = \{S(tatus\ quo), P(reempting), R(esisting), Ca(pitulating)\}$ respectively. The timing and the stage game payoffs in period t are shown in table 1.[1]

Table 1: Timing and the Stage Game Payoffs in Period t

		Outcomes	**Payoffs for the Potential Challenger and Hegemon**
Both keeping the Status Quo **(S)**		Status Quo	$(s, 1)$
Hegemon preempting **(P)**	Potential Challenger resisting **(R)**	War	$(p(y_t), 1 - p(y_t))$
	Potential Challenger capitulating **(Ca)**	Single Hegemony	$(0, 1)$
Potential Challenger challenging **(C)**	Hegemon resisting **(R)**	War	$(p(y_t), 1 - p(y_t))$
	Hegemon capitulating **(Ca)**	Peaceful Transit	$(1, s)$

Here, the chance of winning a war depends on the relative capabilities of the hegemon and the potential challenger. Specifically, if there is a war at period t, given

[1] Who moves first in the stage game does not matter. If one keeps status quo, the other has the option of keeping status quo or challenging (preempting). In the latter case, the opponent then decide whether to resist or capitulate.

the capabilities of the potential challenger y_t, the winning probability for the potential challenger is $p(y_t)$, which is an increasing function of y_t. y_t is growing at rate $g_t > 0$ in period t, i.e., $y_{t+1} = (1 + g_t)y_t$. We assume that there exists some "**fuzzy area**" $(\underline{y}, \overline{y})$, such that only if y_t is greater than the lower bound $\underline{y}$, is there a positive chance for the potential challenger to win the war; if y_t is greater than or equal to the upper bound $\overline{y}$, the chance for the potential challenger to win the war equals one. Further, we assume that there exists some $\widetilde{y} \in (\underline{y}, \overline{y})$ with $p(\widetilde{y}) \geq 1/2$, such that $\delta(1 + g_t) > 1$ for $y_{t+1} = (1 + g_t)y_t \leq \widetilde{y}$ and $\delta(1 + g_t) \leq 1$ for $y_{t+1} = (1 + g_t)y_t > \widetilde{y}$. That is to say, $\widetilde{y}$ is the **turning point** of the growth of the capabilities of the potential challenger. This captures the idea that if $y_{t+1} = (1 + g_t)y_t \leq \widetilde{y}$, the potential challenger is in the stage of "**taking-off**" with higher growth rate $g_t > 1/\delta - 1$; if $y_{t+1} = (1 + g_t)y_t > \widetilde{y}$, the potential challenger is in the stage of "**surpassing**" with lower growth rate $g_t \leq 1/\delta - 1$.[2] In addition, if $y_t \in (\underline{y}, \widetilde{y})$, $p' > 0$ and $p'' > 0$; if $y_t \in (\widetilde{y}, \overline{y})$, $p' > 0$ and $p'' < 0$. This says that if y_t is in the "taking-off" stage, the winning function of the potential challenger $p(y_t)$ is convex, whereas if y_t is in the "surpassing" stage, $p(y_t)$ is concave. The winning function of the potential challenger $p(y_t)$ is illustrated in figure 1.

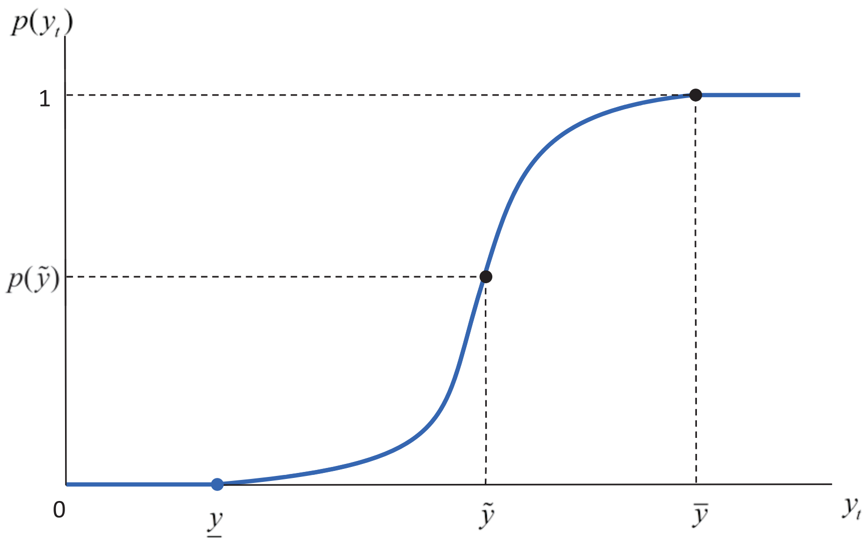

Figure 1: Winning Probability of the Potential Challenger in a War

In addition, we assume the winner suffers the capabilities loss due to the war, which is an increasing function of the opponent's capabilities. That is, if the hegemony wins the war in period t, its capabilities will be reduced by the amount $D(y_t)$, whereas if the potential challenger wins the war in period t, its capabilities will be reduced by the amount $D(1/y_t)$, where $D' > 0$ and $D'' > 0$.

[2] In this sense, $\delta(1+g_t)-1$ is the "real" growth rate of the capabilities of the potential challenger, taking into account of the discount factor.

2.2 Dynamic Game

For the dynamic game, we need to consider the continuation payoffs in addition to the stage payoffs. As in table 1, there are four possible outcomes in period t: Status Quo, War, Single Hegemony, and Peaceful Transit. If the status quo continues, the expected discounted payoff for the potential challenger is $s + \delta U^C_{t+1}(y_{t+1})$, where $U^C_{t+1}(y_{t+1})$ is its continuation payoff for the potential challenger in period $t+1$. Meanwhile, the expected discounted payoff for the hegemony is $1 + \delta U^H_{t+1}(y_{t+1})$, where $U^H_{t+1}(y_{t+1})$ is its continuation payoff in period $t+1$. If there is a war, the loser is out of the game and the winner becomes the single hegemony, who enjoys the periodic hegemonic bonus. Therefore, if there is a war in period t, the expected discounted payoff for the potential challenger and the hegemon is $\big(p(y_t)\frac{1}{1-\delta}, (1-p(y_t))\frac{1}{1-\delta}\big)$. Instead, if the hegemon preempts and the potential challenger capitulates, the hegemon becomes the single hegemon without a war, whereas the potential challenger is out of the game. The expected discounted payoff for the potential challenger and the hegemon is $\big(0, \frac{1}{1-\delta}\big)$.[3] If peaceful transit occurs, the hegemon and the potential challenger exchange their seats. The potential challenger becomes the hegemony and enjoys the hegemonic bonus. Its expected discounted payoff is $1+\delta V^C_{t+1}(y_{t+1})$, where $V^C_{t+1}(y_{t+1})$ is its continuation payoff in period $t+1$. Meanwhile, the hegemony loses the hegemonic bonus, but still enjoys the benefit share of the follower, s. Its expected discounted payoff is $s + \delta V^H_{t+1}(y_{t+1})$, where $V^H_{t+1}(y_{t+1})$ is its continuation payoff in period $t+1$.

Table 2: Expected Discounted Payoffs in Period t

Outcomes	**Expected Discounted Payoffs for the Potential Challenger and Hegemon**
Status Quo	$\Big(s + \delta U^C_{t+1}(y_{t+1}), 1 + \delta U^H_{t+1}(y_{t+1})\Big)$
War	$\Big(p(y_t)\frac{1}{1-\delta}, (1-p(y_t))\frac{1}{1-\delta}\Big)$
Single Hegemony	$\Big(0, \frac{1}{1-\delta}\Big)$
Peaceful Transit	$\Big(1 + \delta V^C_{t+1}(y_{t+1}), s + \delta V^H_{t+1}(y_{t+1})\Big)$

Our solution concept is Subgame Perfect Nash Equilibrium (**SPNE**). The following lemma shows the condition of peaceful transit.

Lemma 1 *There exists a critical period T, such that $p(y_{T+1}) > 1-s$ and $p(y_T) \leq 1-s$. If the status quo continues through period T, peaceful transit will occur in period $T+1$. Any challenging will be resisted by the hegemon before period $T+1$.*

[3] As $p(y_t) \geq 0$, $p(y_t)\frac{1}{1-\delta} \geq 0$. If the hegemon preempts, the dominant strategy for the potential challenger is to resist. That is, if the hegemon preempts, war begins.

Intuitively, the capabilities of the potential challenger is growing at a positive rate over time, relative to the capabilities of the hegemon. If the hegemony capitulates in some period, it will capitulate thereafter and the subsequent continuation payoff for the hegemon will be $\frac{s}{1-\delta}$. If the potential challenger challenges in period t, the hegemon must decide whether to resist or capitulate and the corresponding expected discounted payoffs are: $(1-p(y_t))\frac{1}{1-\delta}$ and $s+\delta V^H_{t+1}(y_{t+1}) = s+\delta\frac{s}{1-\delta} = \frac{s}{1-\delta}$. Clearly, if $p(y_t) > 1-s$, the hegemon will capitulate if the potential challenger challenges, otherwise resist. Therefore, there exists a critical period T, such that $p(y_{T+1}) > 1-s$ and $p(y_T) \leq 1-s$. If the status quo continues through period T, peaceful transit will occur in period $T+1$. Any challenging will be resisted by the hegemon before period $T+1$. Notice that $y_T < \overline{y}$.

The following proposition shows the existence of a unique Subgame Perfect Nash Equilibrium (**SPNE**), in which at any give period $t \leq T$, if y_t is large, the potential challenger challenges; if y_t is small, the hegemon preempts; if y_t is in the middle, they end up with the status quo and the game continues to the next period.

Proposition 1 *There exists a unique Subgame Perfect Nash Equilibrium (**SPNE**) with a recursive structure. Specifically, depending on the future scenario, $\forall t \leq T$, there are $T-t+1$ possible cases.*

For case $i = 1, ..., T-t$, if the status quo stands in period t and the game continues to period $t+1$, the status quo continues from period $t+1$ to period $t+i-1$ and then war occurs in period $t+i$. If $p(y_t)-\delta^i p(y_{t+i}) \geq s(1-\delta^i)$, the potential challenger challenges and the hegemon resists; if $0 \leq p(y_t) - \delta^i p(y_{t+i}) < s(1-\delta^i)$, the potential challenger does not challenge and the hegemon stays with the status quo; if $p(y_t) - \delta^i p(y_{t+i}) < 0$, the potential challenger does not challenge and the hegemon preempts.

For case $i = T-t+1$, if the status quo stands in period t and the game continues to period $t+1$, the status quo continues from period $t+1$ to period $t+i-1 = T$ and then peaceful transit occurs in period $t+i = T+1$. If $p(y_t) \geq s+\delta^i(1-s)$, the potential challenger challenges and the hegemon resists; if $\delta^i(1-s) \leq p(y_t) < s+\delta^i(1-s)$, the potential challenger does not challenge and the hegemon stays with the status quo; if $p(y_t) < \delta^i(1-s)$, the potential challenger does not challenge and the hegemon preempts.

Proof. See the Appendix. ■

Intuitively, from Lemma 1, if the status quo continues through period T, peaceful transit will occur in period $T+1$. Any challenging will be resisted by the hegemon before period $T+1$. Backward to period T, both the potential challenger and the hegemon know that peaceful transit will occur in period $T+1$, if the status quo stands in period T and the game continues. There are three possible scenarios: if y_T is large, the potential challenger challenges; if y_T is small, the hegemon preempts; if

y_T is in the middle, they end up with the status quo and the game continues to the next period $T + 1$ and peaceful transit occurs.

Backward to period $T - 1$, both the potential challenger and the hegemon know that if the status quo stands in period $T-1$ and the game continues to period T, there are two possible cases: case 1, war occurs in period T (either the potential challenger challenges or the hegemon preempts); case 2, the status quo stands in period T and then peaceful transit occurs in period $T + 1$. Again, in each of the two cases, there are three possible scenarios: if y_{T-1} is large, the potential challenger challenges; if y_{T-1} is small, the hegemon preempts; if y_{T-1} is in the middle, they end up with the status quo and the game continues to the next period T.

... ...

Continuing backward to any arbitrary period $t \leq T$, both the potential challenger and the hegemon know that if the status quo stands in period t and the game continues to period $t+1$, there are $T-t+1$ possible cases: case $i = 1, ..., T-t$, the status quo continues from period $t+1$ to period $t+i-1$ and then war occurs in period $t+i$; case $i = T-t+1$, the status quo continues from period $t+1$ to period $t+i-1 = T$ and then peaceful transit occurs in period $t+i = T+1$. Again, in each of the $T-t+1$ cases, there are three possible scenarios: if y_{t-1} is large, the potential challenger challenges; if y_{t-1} is small, the hegemon preempts; if y_{t-1} is in the middle, they end up with the status quo and the game continues to the next period $t + 1$.

2.3 Equilibrium Characterization

Now, we turn to further characterize the unique Subgame Perfect Nash Equilibrium (**SPNE**) specified in proposition 1. The following lemma shows that $p(y_t) - \delta p(y_{t+1})$ is decreasing in y_t if y_{t+1} is in the "taking-off" stage, whereas $p(y_t) - \delta p(y_{t+1})$ is increasing in y_t if y_t is in the "surpassing" stage.

Lemma 2 *$p(y_t) - \delta p(y_{t+1})$ is decreasing in y_t if $y_{t+1} = (1+g_t)y_t \leq \widetilde{y}$; $p(y_t) - \delta p(y_{t+1})$ is increasing in y_t if $y_t > \widetilde{y}$.*

Proof. Taking the derivative of $p(y_t) - \delta p(y_{t+1})$ with respect to y_t,

$$\frac{d\left[p(y_t) - \delta p(y_{t+1})\right]}{dy_t} = p'(y_t) - \delta(1 + g_t)p'(y_{t+1})$$

If y_{t+1} is in the "taking-off" stage, the winning function of the potential challenger is convex, $p'(y_t) \leq p'(y_{t+1})$; meanwhile, $\delta(1 + g_t) > 1$. Therefore, the term in the equation above will be less than zero and $p(y_t) - \delta p(y_{t+1})$ is decreasing in y_t.

If y_t is in the "surpassing" stage, the winning function of the potential challenger is concave, $p'(y_t) \geq p'(y_{t+1})$; meanwhile, $\delta(1 + g_t) \leq 1$. Therefore, the term in the equation above will be greater than or equal to zero and $p(y_t) - \delta p(y_{t+1})$ is increasing in y_t. ■

By proposition 1, the lemma above implies that in the "taking-off" stage, the potential challenger is less likely to challenge and the hegemon is more likely to preempt as time goes by with y_t growing; in the "surpassing" stage, the potential challenger is more likely to challenge and the hegemon is less likely to preempt as time goes by with y_t growing. Consequently, we have the following proposition, which shows that the hegemon is willing to wait till to some optimal point to preempt before the turning point, or will never preempt after the turning point; the potential challenger will either challenge immediately, wait till to some optimal point after the turning point to challenge, or wait till to period $T+1$ for the peaceful transit.

Proposition 2 *There exists a $y' \leq \widetilde{y}$, such that*

$$y' = \begin{cases} y_i & \text{if } p(y_{i-1}) - \delta p(y_i) \geq 0 \text{ and } p(y_i) - \delta p(y_{i+1}) < 0 \\ \widetilde{y} & \text{if } p(y_i) - \delta p(y_{i+1}) \geq 0 \quad \forall y_i \leq \widetilde{y} \end{cases}$$

The hegemon will never preempt for $y_t < y'$ or $y_t > \widetilde{y}$.

There exists a $y'' \geq \widetilde{y}$, such that

$$y'' = \begin{cases} y_i & \text{if } p(y_{i-1}) - \delta p(y_i) \geq s(1-\delta) \text{ and } p(y_i) - \delta p(y_{i+1}) < s(1-\delta) \\ y_T & \text{if } p(y_i) - \delta p(y_{i+1}) < s(1-\delta) \quad \forall y_i \leq y_T \end{cases}$$

The potential challenger will never challenge in between y_t and y'', for $y_t < y''$.

Proof. By the one-shot deviation principle, consider the hegemon's decision to preempt in the current period t or the next period $t+1$. If preempting in the current period t, the expected discounted payoff is $(1 - p(y_t))\frac{1}{1-\delta}$, whereas if preempting in the next period $t+1$, the expected discounted payoff is $1+\delta(1-p(y_{t+1}))\frac{1}{1-\delta}$, provided that the status quo stands in period t and the game continues to period $t+1$. Clearly, if $p(y_t) - \delta p(y_{t+1}) \geq 0$, the hegemon will wait; otherwise, the hegemon will preempt in period t instead of $t+1$. By Lemma 2, $p(y_t) - \delta p(y_{t+1})$ is decreasing in y_t if y_{t+1} is in the "taking-off" stage, whereas $p(y_t) - \delta p(y_{t+1})$ is increasing in y_t if y_t is in the "surpassing" stage. Therefore, we may find some $y_i \leq \widetilde{y}$, such that $p(y_{i-1}) - \delta p(y_i) \geq 0$ and $p(y_i) - \delta p(y_{i+1}) < 0$. The hegemon is willing to wait till to y_i to preempt. Instead, if $p(y_i) - \delta p(y_{i+1}) \geq 0$, $\forall y_i \leq \widetilde{y}$, the hegemon will not preempt in the "taking-off" stage. It will not preempt in the "surpassing" stage either, as $p(y_t) - \delta p(y_{t+1})$ is increasing in y_t in the "surpassing" stage.

Similarly, consider the potential challenger's decision to challenge in the current period t or the next period $t+1$. If challenging in the current period t, the expected discounted payoff is $p(y_t)\frac{1}{1-\delta}$, whereas if challenging in the next period $t+1$, the expected discounted payoff is $s + \delta p(y_{t+1})\frac{1}{1-\delta}$, provided that the status quo stands in period t and the game continues to period $t+1$. Clearly, if $p(y_t) - \delta p(y_{t+1}) \geq s(1-\delta)$, the potential challenger will challenge in period t instead of $t+1$; otherwise, the potential challenger will wait till period $t+1$ to challenge. By Lemma 2, $p(y_t) - \delta p(y_{t+1})$ is decreasing in y_t if y_{t+1} is in the "taking-off" stage, whereas $p(y_t) - \delta p(y_{t+1})$ is increasing in y_t if y_t is in the "surpassing" stage. Therefore, we may find some $y_i \geq \widetilde{y}$, such that $p(y_{i-1}) - \delta p(y_i) \geq s(1-\delta)$ and $p(y_i) - \delta p(y_{i+1}) < s(1-\delta)$. If the potential challenger does not challenge in the current period t, it wait till to y_i to challenge. Instead, if $p(y_i) - \delta p(y_{i+1}) < s(1-\delta)$, $\forall y_i \leq y_T$, the potential challenger will wait till to period $T+1$ for the peaceful transit. ■

The typical equilibrium is illustrated in figure 2. If in the current period t, $y_t < y'$,

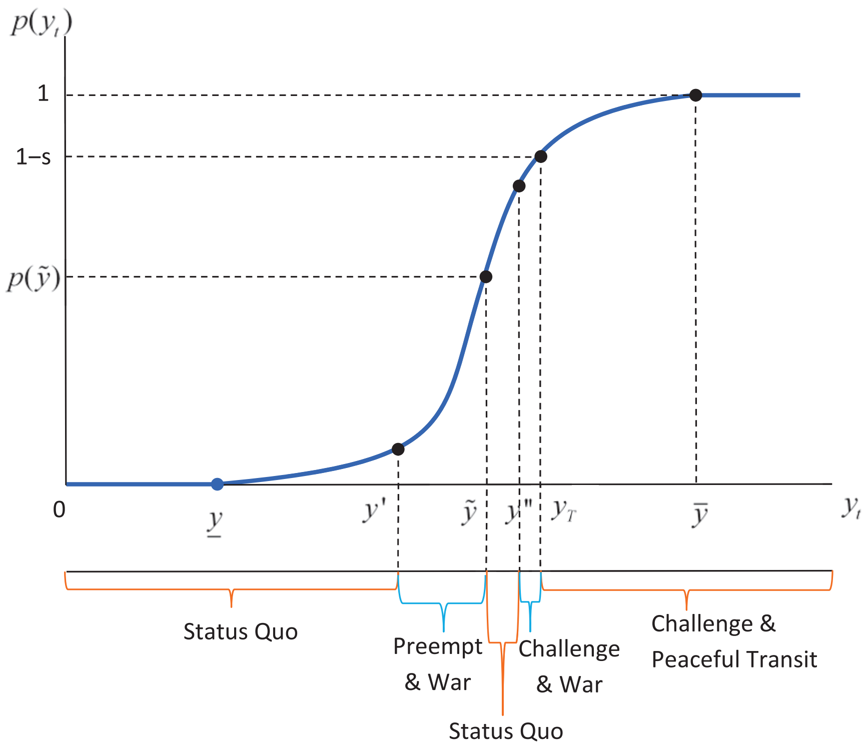

Figure 2: The Typical Equilibrium

the hegemon will wait and the potential challenger will not challenge and the status quo stands; if $y' \leq y_t < \widetilde{y}$, the hegemon will preempt immediately and war occurs; if $\widetilde{y} \leq y_t < y''$, the hegemon will not preempt and the potential challenger will not challenge and the status quo stands; if $y'' \leq y_t < y_T$, the potential challenger will challenge immediately and war occurs; if $y_t \geq y_T$, the hegemon will challenger and peaceful transit occurs.

3 Dual Boiling Frog Effects

The following corollary says that as δ increases, the hegemon is willing to preempt earlier at a lower lever of the capabilities of the potential challenger. But it is uncertainty whether the potential challenger is willing to challenge earlier or later.

Corollary 1 *y' is an decreasing function of δ.*

Clearly, as δ increases, $p(y_t) - \delta p(y_{t+1})$ decreases. From proposition 2, it is easy to see that y' is decreasing. However, as δ increases, $s(1-\delta)$ decreases too. Therefore, we cannot decide if y'' is increasing or decreasing.

Further, the following corollary says that if the potential challenger grows on a faster path, then the hegemon is willing to preempt at a lower lever of the capabilities of the potential challenger, while the potential challenger is willing to challenge at a higher lever of its capabilities.

Corollary 2 *If the potential challenge grows on a faster path, y' is decreasing while y'' is increasing.*

Clearly, if g_t increases, $p(y_t) - \delta p(y_{t+1})$ decreases. From proposition 2, it is easy to see that y' is decreasing and y'' is increasing.

By the corollaries above, we could have some variations of the typical equilibrium as described in proposition 2. For instance, as δ goes to zero, the potential challenger may have incentive to challenge immediately, even though y_t is small. At the other extreme, as δ goes to one, y' goes to $\underline{y}$ and the hegemon will preempt immediately. Further, if δ and growth rate are in some middle range, such that $y' = \widetilde{y}$ and $y'' = y_T$, the hegemon will not preempt and the potential challenger will not challenge and the status quo continues through period T and peaceful transit occurs in period $T+1$. We call this **Dual Boiling Frog Effects**, which is described in the following proposition.

Proposition 3 *The dual boiling frog effects occurring in the middle range of capability catching-up rate prevent a dominant state from preempting and a rising state from challenging the other side.*

4 Expectation Divergence

Following the literature of behavior economics, suppose the hegemon and the potential challenger hold different views of the growth path of the potential challenger, about which they "agree to disagree." Simply because they are overconfident about the precision of their private information.

The following proposition shows that divergent expectations for favorable comparative growth advantage motivate both parties to keep the status quo. The hegemon and the potential challenger could end up with the following situation: to the point view of the potential challenger, the hegemon should have preempted earlier, while the hegemon does not, provided that $\widehat{y}$ is small.

Proposition 4 *Suppose the potential challenger is optimistic and believes its capabilities will grow along $\{g_t\}$, where $g_t > 0$ for all t, while the hegemon believes that the growth of the potential challenger's capabilities will be halted eventually and remain stagnant at some level $\widehat{y}$.*

If $p(\widehat{y}) < s$, we have the following equilibrium: the potential challenger does not challenge and the hegemon does not preempt, and the status quo continues till to $\widehat{y}$.

Proof. Consider the case that the growth of the potential challenger's capabilities is halted eventually and remain stagnant at some level $\widehat{y}$. As there is no further growth, the best response for the potential challenger will be challenge immediately or never thereafter. If the potential challenger challenges immediately, the hegemon will decide whether to resist or capitulate. In the former case, the corresponding expected discounted payoffs are: $\left(p(\widehat{y})\frac{1}{1-\delta}, (1-p(\widehat{y}))\frac{1}{1-\delta}\right)$. In the latter case, peaceful transit occurs and the corresponding expected discounted payoffs are: $\left(\frac{1}{1-\delta}, \frac{s}{1-\delta}\right)$. If the hegemon preempts immediately, the corresponding expected discounted payoffs are: $\left(p(\widehat{y})\frac{1}{1-\delta}, (1-p(\widehat{y}))\frac{1}{1-\delta}\right)$. If both the hegemon and the potential challenger keep the status quo, the status quo continues forever and the corresponding expected discounted payoffs are: $\left(\frac{s}{1-\delta}, \frac{1}{1-\delta}\right)$. Clearly, the hegemon will never preempt. Depending on $\widehat{y}$, there are three possible cases: if $p(\widehat{y}) < s$, both the hegemon and the potential challenger keep the status quo and the status quo continues forever; if $s \leq p(\widehat{y}) < 1-s$, the potential challenger challenges immediately, the hegemon resists, and war occurs; if $p(\widehat{y}) \geq 1-s$, the potential challenger challenges immediately, the hegemon capitulates, and peaceful transit occurs.

If the hegemon believes that the growth of the potential challenger's capabilities will be halted eventually and remain stagnant at $\widehat{y}$ and $p(\widehat{y}) < s$, by the result above, it will never preempt. In contrast, if the potential challenger is optimistic and believes its capabilities will grow along $\{g_t\}$, where $g_t > 0$ for all t, by proposition 2, it will either challenge immediately or wait till to y''. Note, $p(y'') \geq p(\widetilde{y}) \geq 1/2 \geq s > p(\widehat{y})$. Therefore, if the potential challenger does not challenge immediately, it will not challenge till $\widehat{y}$.

In addition, if $y' < \widehat{y}$, the hegemon and the potential challenger could end up with the situation: to the point view of the potential challenger, the hegemon should have preempted earlier, while the hegemon does not, provided that $\widehat{y} < s$. $\blacksquare$

The implication is that due to "agree to disagree", the status quo could continue till to the point of "agree to disagree" is solved. At that point, if the potential challenger's capabilities continues growing along $\{g_t\}$, where $g_t > 0$ for all t, the hegemon may preempt immediately, even though it should have preempt earlier if it knew the sustained growth of its opponent. Instead, if indeed the growth of the potential challenger's capabilities is halted eventually and remains stagnant at $\widehat{y} < s$, the hegemon will become the single hegemony and enjoy the periodic hegemonic bonus. The potential challenger will be out of the game as there is no way for it to catch up with the hegemon.

5 Relative Advantage Deterioration

Consider the case of more than one potential challenger (rising state). The story will be totally changed, as the winner of the power transition still needs to face the new emerging "#2". Since the winner suffers the capabilities loss due to the war, the winner may even at a worse situation than staying with the status quo. Consequently, it is the third party that benefits from the tussle with the third-party impediment.

The following proposition shows that with the concerns of relative advantage deterioration over a third party in the new power structure after even a successful war, both the hegemon and the potential challenger are less willing to star a war and the status quo are therefore more likely to be maintained.

Proposition 5 *Suppose there exists a third player with the capabilities $z_t < y_t$ at period t, which is growing over time at rate $g_t' \geq g_t > 0$ in period t. Compared to case without the third player, the hegemon is less likely to preempt and the potential challenger is less likely to challenge in period t.*

Proof. By the one-shot deviation principle, consider the hegemon's decision to preempt in the current period t or not. If preempting in the current period t, the expected discounted payoff is $(1 - p(y_t))\left[1 + \delta U_{t+1}^H\left(\frac{z_{t+1}}{1-D(y_t)}\right)\right]$, whereas if not preempting in the current period t, the expected discounted payoff is $\left[1 + \delta U_{t+1}^H(y_{t+1})\right]$, provided that the status quo stands in period t and the game continues to period $t+1$.[4] From section 2, $U_{t+1}^H(\cdot)$ is a decreasing function. Clearly, $(1-p(y_t))\left[1 + \delta U_{t+1}^H\left(\frac{z_{t+1}}{1-D(y_t)}\right)\right] - \left[1 + \delta U_{t+1}^H(y_{t+1})\right]$ is decreasing in z_{t+1},[5] which implies that the hegemon is less likely to preempt in period t as z_{t+1} increases.

[4] With a slight abuse of notation, we still use $U_{t+1}^H(\cdot)$ to denote the continuation payoff in period $t+1$ for the hegemon, even with the third player. The existence of the third player is kind of "second-order effect", which is effective only when it becomes the new emerging "#2" after a war between the hegemon and the potential challenger.

[5] In particular, for $0 \leq z_{t+1} \leq (1 - D(y_t))\underline{y}$, $U_{t+1}^H\left(\frac{z_{t+1}}{1-D(y_t)}\right)$ is constant at its upper bound $\frac{1}{1-\delta}$.

Similarly, by the one-shot deviation principle, consider the potential challenger's decision to challenge in the current period t or not. If challenging in the current period t, the expected discounted payoff is $p(y_t)\left[1+\delta U_{t+1}^H\left(\frac{z_{t+1}}{y_t-D(1/y_t)}\right)\right]$, whereas if not challenging in the current period t, the expected discounted payoff is $\left[s+\delta U_{t+1}^C(y_{t+1})\right]$, provided that the status quo stands in period t and the game continues to period $t+1$. From section 2, $U_{t+1}^H(\cdot)$ is a decreasing function. Clearly, $p(y_t)\left[1+\delta U_{t+1}^H\left(\frac{z_{t+1}}{y_t-D(1/y_t)}\right)\right]-\left[s+\delta U_{t+1}^C(y_{t+1})\right]$ is decreasing in z_{t+1},[6] which implies that the potential challenger is less likely to challenge in period t as z_{t+1} increases. ■

6 Conclusion

We present a prospect theory model to explain why power transitions do not necessarily lead to war. The potential challenger (rising state) appears to be surpassing the hegemon (declining state) in capabilities. The potential challenger must decide whether to test its growing capabilities, and the hegemon must decide whether to resist a challenge or preempt to eliminate the potential challenger. We show the existence of a unique Subgame Perfect Nash Equilibrium (**SPNE**), in which at any given period, if the capabilities of the potential challenger is large, the potential challenger challenges; if the capabilities of the potential challenger is small, the hegemon preempts; if the capabilities of the potential challenger is in the middle, they end up with the status quo.

We find that three major mechanisms prevent the occurrence of potential power transition wars. First, the dual boiling frog effects occurring in the middle range of capability catching-up rate prevent a dominant state from preempting and a rising state from challenging the other side. Second, divergent expectations for favorable comparative growth advantage, about which they "agree to disagree", motivate both parties to keep the status quo. Third, the concerns of relative advantage deterioration over a third party in the new power structure after even a successful war also deter both parties from starting a war. Simply because, with the third-party impediment, the winner suffers the capabilities loss due to the war, and may even at a worse situation when facing the new emerging "#2" than staying with the status quo. Consequently, it is the third party that benefits from the tussle.

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[6] In particular, for $0 \le z_{t+1} \le (y_t - D(1/y_t))\underline{y}$, $U_{t+1}^H\left(\frac{z_{t+1}}{y_t-D(1/y_t)}\right)$ is constant at its upper bound $\frac{1}{1-\delta}$.

Appendix

Proof of Proposition 1

From Lemma 1, if the status quo continues through period T, peaceful transit will occur in period $T+1$. Any challenging will be resisted by the hegemon before period $T+1$.

Backward to period T, both the potential challenger and the hegemon know that peaceful transit will occur in period $T+1$, if the status quo stands in period T and the game continues. Therefore, the continuation payoff in period $T+1$ for the potential challenger $V^C_{T+1}(y_{T+1}) = \frac{1}{1-\delta}$; the continuation payoff in period $T+1$ for the hegemon $V^H_{T+1}(y_{T+1}) = \frac{s}{1-\delta}$.

If the hegemon preempts in period T, war begins and the corresponding expected discounted payoffs are: $\left(p(y_T)\frac{1}{1-\delta}, (1-p(y_T))\frac{1}{1-\delta}\right)$. If the potential challenger challenges in period T, the hegemon resists and the corresponding expected discounted payoffs are: $\left(p(y_T)\frac{1}{1-\delta}, (1-p(y_T))\frac{1}{1-\delta}\right)$. If the hegemon and the potential challenger keep the status quo, the corresponding expected discounted payoffs are: $\left(s+\delta\frac{1}{1-\delta}, 1+\delta\frac{s}{1-\delta}\right)$. Therefore, if $p(y_T) \geq s+\delta(1-s)$, the potential challenger challenges and the hegemon resists; if $\delta(1-s) \leq p(y_T) < s+\delta(1-s)$, both the hegemon and the potential challenger stay with the status quo; if $p(y_T) < \delta(1-s)$, the hegemon preempts.

Backward to period $T-1$, both the potential challenger and the hegemon know that if the status quo stands in period $T-1$ and the game continues to period T, there are two possible cases: case 1, war occurs in period T; case 2, the status quo stands in period T and then peaceful transit occurs in period $T+1$.

In case 1, the continuation payoffs in period T for the potential challenger and the hegemon are $U^C_T(y_T) = p(y_T)\frac{1}{1-\delta}$ and $U^H_T(y_T) = (1-p(y_T))\frac{1}{1-\delta}$ respectively. If the hegemon preempts in period $T-1$, war begins and the corresponding expected discounted payoffs are: $\left(p(y_{T-1})\frac{1}{1-\delta}, (1-p(y_{T-1}))\frac{1}{1-\delta}\right)$. If the potential challenger challenges in period $T-1$, the hegemon resists and the corresponding expected discounted payoffs are: $\left(p(y_{T-1})\frac{1}{1-\delta}, (1-p(y_{T-1}))\frac{1}{1-\delta}\right)$. If the hegemon and the potential challenger keep the status quo, the corresponding expected discounted payoffs are: $\left(s+\delta p(y_T)\frac{1}{1-\delta}, 1+\delta(1-p(y_T))\frac{1}{1-\delta}\right)$. Therefore, if $p(y_{T-1}) - \delta p(y_T) \geq s(1-\delta)$, the potential challenger challenges and the hegemon resists; if $0 \leq p(y_{T-1}) - \delta p(y_T) < s(1-\delta)$, both the hegemon and the potential challenger stay with the status quo; if $p(y_{T-1}) - \delta p(y_T) < 0$, the hegemon preempts.

In case 2, the continuation payoffs in period T for the potential challenger and the hegemon are $U^C_T(y_T) = s+\delta\frac{1}{1-\delta}$ and $U^H_T(y_T) = 1+\delta\frac{s}{1-\delta}$ respectively. If the hegemon preempts in period $T-1$, war begins and the corresponding expected discounted payoffs are: $\left(p(y_{T-1})\frac{1}{1-\delta}, (1-p(y_{T-1}))\frac{1}{1-\delta}\right)$. If the potential challenger challenges in period $T-1$, the hegemon resists and the corresponding expected discounted payoffs are: $\big(p(y_{T-1})\frac{1}{1-\delta},(1-p(y_{T-1}))\frac{1}{1-\delta}\big)$. If the hegemon and the potential challenger keep the status quo, the corresponding expected discounted payoffs are: $\big(s+\delta(s+\delta\frac{1}{1-\delta}),1+\delta(1+\delta\frac{s}{1-\delta})\big)$. Therefore, if $p(y_{T-1}) \geq s+\delta^2(1-s)$, the potential challenger challenges and the hegemon resists; if $\delta^2(1-s) \leq p(y_{T-1}) < s+\delta^2(1-s)$, both the hegemon and the potential challenger stay with the status quo; if $p(y_{T-1}) < \delta^2(1-s)$, the hegemon preempts.

... ...

Continuing backward to any arbitrary period $t \leq T$, both the potential challenger and the hegemon know that if the status quo stands in period t and the game continues to period $t+1$, there are $T-t+1$ possible cases: case $i = 1, ..., T-t$, the status quo continues from period $t+1$ to period $t+i-1$ and then war occurs in period $t+i$; case $i = T-t+1$, the status quo continues from period $t+1$ to period $t+i-1 = T$ and then peaceful transit occurs in period $t+i = T+1$.

For case $i = 1$, the continuation payoffs in period $t+1$ for the potential challenger and the hegemon are $U^C_{t+1}(y_{t+1}) = p(y_{t+1})\frac{1}{1-\delta}$ and $U^H_{t+1}(y_{t+1}) = (1-p(y_{t+1}))\frac{1}{1-\delta}$ respectively. If the hegemon preempts in period t, war begins and the corresponding expected discounted payoffs are: $\big(p(y_t)\frac{1}{1-\delta},(1-p(y_t))\frac{1}{1-\delta}\big)$. If the potential challenger challenges in period t, the hegemon resists and the corresponding expected discounted payoffs are: $\big(p(y_t)\frac{1}{1-\delta},(1-p(y_t))\frac{1}{1-\delta}\big)$. If the hegemon and the potential challenger keep the status quo, the corresponding expected discounted payoffs are: $\big(s+\delta p(y_{t+1})\frac{1}{1-\delta},1+\delta(1-p(y_{t+1}))\frac{1}{1-\delta}\big)$. Therefore, if $p(y_t)-\delta p(y_{t+1}) \geq s(1-\delta)$, the potential challenger challenges and the hegemon resists; if $0 \leq p(y_t)-\delta p(y_{t+1}) < s(1-\delta)$, both the hegemon and the potential challenger stay with the status quo; if $p(y_t)-\delta p(y_{t+1}) < 0$, the hegemon preempts.

For case $i = 2, ..., T-t$, the continuation payoffs in period $t+1$ for the potential challenger and the hegemon are $U^C_{t+1}(y_{t+1}) = \sum_{j=2}^{i}\delta^{j-2}s + \delta^{i-1}p(y_{t+i})\frac{1}{1-\delta}$ and $U^H_{t+1}(y_{t+1}) = \sum_{j=2}^{i}\delta^{j-2} + \delta^{i-1}(1-p(y_{t+i}))\frac{1}{1-\delta}$ respectively. If the hegemon preempts in period t, war begins and the corresponding expected discounted payoffs are: $\big(p(y_t)\frac{1}{1-\delta},(1-p(y_t))\frac{1}{1-\delta}\big)$. If the potential challenger challenges in period t, the hegemon resists and the corresponding expected discounted payoffs are: $\big(p(y_t)\frac{1}{1-\delta},(1-p(y_t))\frac{1}{1-\delta}\big)$. If the hegemon and the potential challenger keep the status quo, the corresponding expected discounted payoffs are: $\left(s+\delta\left(\sum_{j=2}^{i}\delta^{j-2}s+\delta^{i-1}p(y_{t+i})\frac{1}{1-\delta}\right),1+\delta\left(\sum_{j=2}^{i}\delta^{j-2}+\delta^{i-1}(1-p(y_{t+i}))\frac{1}{1-\delta}\right)\right)$. Therefore, if $p(y_t)-\delta^i p(y_{t+i}) \geq s(1-\delta^i)$, the potential challenger challenges and the hegemon resists; if $0 \leq p(y_t)-\delta^i p(y_{t+i}) < s(1-\delta^i)$, both the hegemon and the potential challenger stay with the status quo; if $p(y_t) - \delta^i p(y_{t+i}) < 0$, the hegemon preempts.

For case $i = T - t + 1$, the continuation payoffs in period $t + 1$ for the potential challenger and the hegemon are $U^C_{t+1}(y_{t+1}) = \sum_{j=2}^{T-t+1} \delta^{j-2} s + \delta^{T-t} \frac{1}{1-\delta}$ and $U^H_{t+1}(y_{t+1}) = \sum_{j=2}^{T-t+1} \delta^{j-2} + \delta^{T-t} \frac{s}{1-\delta}$ respectively. If the hegemon preempts in period t, war begins and the corresponding expected discounted payoffs are: $\left(p(y_t)\frac{1}{1-\delta}, (1-p(y_t))\frac{1}{1-\delta}\right)$. If the potential challenger challenges in period t, the hegemon resists and the corresponding expected discounted payoffs are: $\left(p(y_t)\frac{1}{1-\delta}, (1-p(y_t))\frac{1}{1-\delta}\right)$. If the hegemon and the potential challenger keep the status quo, the corresponding expected discounted payoffs are: $\left(s + \delta\left(\sum_{j=2}^{T-t+1} \delta^{j-2} s + \delta^{T-t}\frac{1}{1-\delta}\right), 1 + \delta\left(\sum_{j=2}^{T-t+1} \delta^{j-2} + \delta^{T-t}\frac{s}{1-\delta}\right)\right)$. Therefore, if $p(y_t) \geq s + \delta^{T-t+1}(1-s)$, the potential challenger challenges and the hegemon resists; if $\delta^{T-t+1}(1-s) \leq p(y_t) < s + \delta^{T-t+1}(1-s)$, both the hegemon and the potential challenger stay with the status quo; if $p(y_t) < \delta^{T-t+1}(1-s)$, the hegemon preempts. ■

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